US009347273B2

United States Patent
Stowe, II

(10) **Patent No.: US 9,347,273 B2**
(45) **Date of Patent: May 24, 2016**

(54) **METHOD OF ORIENTING A CUTTING ELEMENT**

(71) Applicant: **Calvin J. Stowe, II**, Bellaire, TX (US)

(72) Inventor: **Calvin J. Stowe, II**, Bellaire, TX (US)

(73) Assignee: **BAKER HUGHES INCORPORATED**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/489,788**

(22) Filed: **Sep. 18, 2014**

(65) **Prior Publication Data**

US 2015/0000983 A1 Jan. 1, 2015

Related U.S. Application Data

(62) Division of application No. 12/700,845, filed on Feb. 5, 2010.

(51) **Int. Cl.**
E21B 10/00 (2006.01)
E21B 10/46 (2006.01)

(52) **U.S. Cl.**
CPC ***E21B 10/00*** (2013.01); ***E21B 10/46*** (2013.01)

(58) **Field of Classification Search**
USPC 175/376, 398, 401, 426, 430, 431; 407/102–109, 113–117; 30/353, 357
See application file for complete search history.

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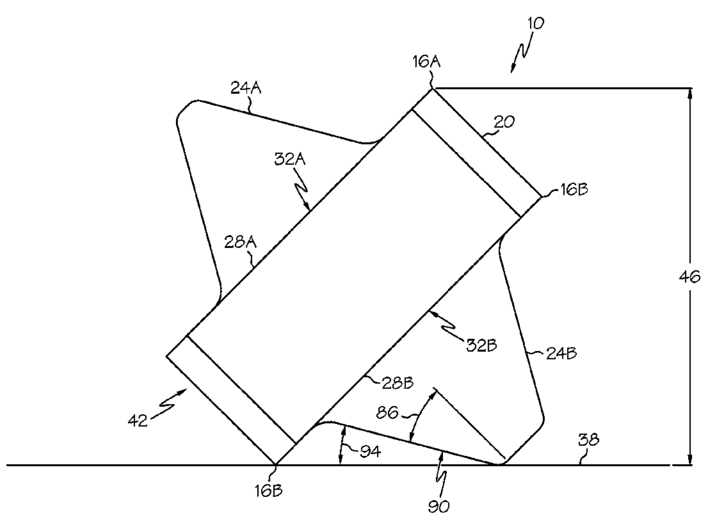
Primary Examiner — Taras P Bemko
(74) *Attorney, Agent, or Firm* — Cantor Colburn LLP

(57) **ABSTRACT**

A method of orienting a cutting element includes, configuring the cutting element so that gravitational forces acting thereon against a support surface bias the cutting element toward a specific orientation relative to the support surface. The specific orientation is such that at least one support and at least one edge of a gilmoid formed by intersections of surfaces of the gilmoid contact the support surface.

11 Claims, 6 Drawing Sheets



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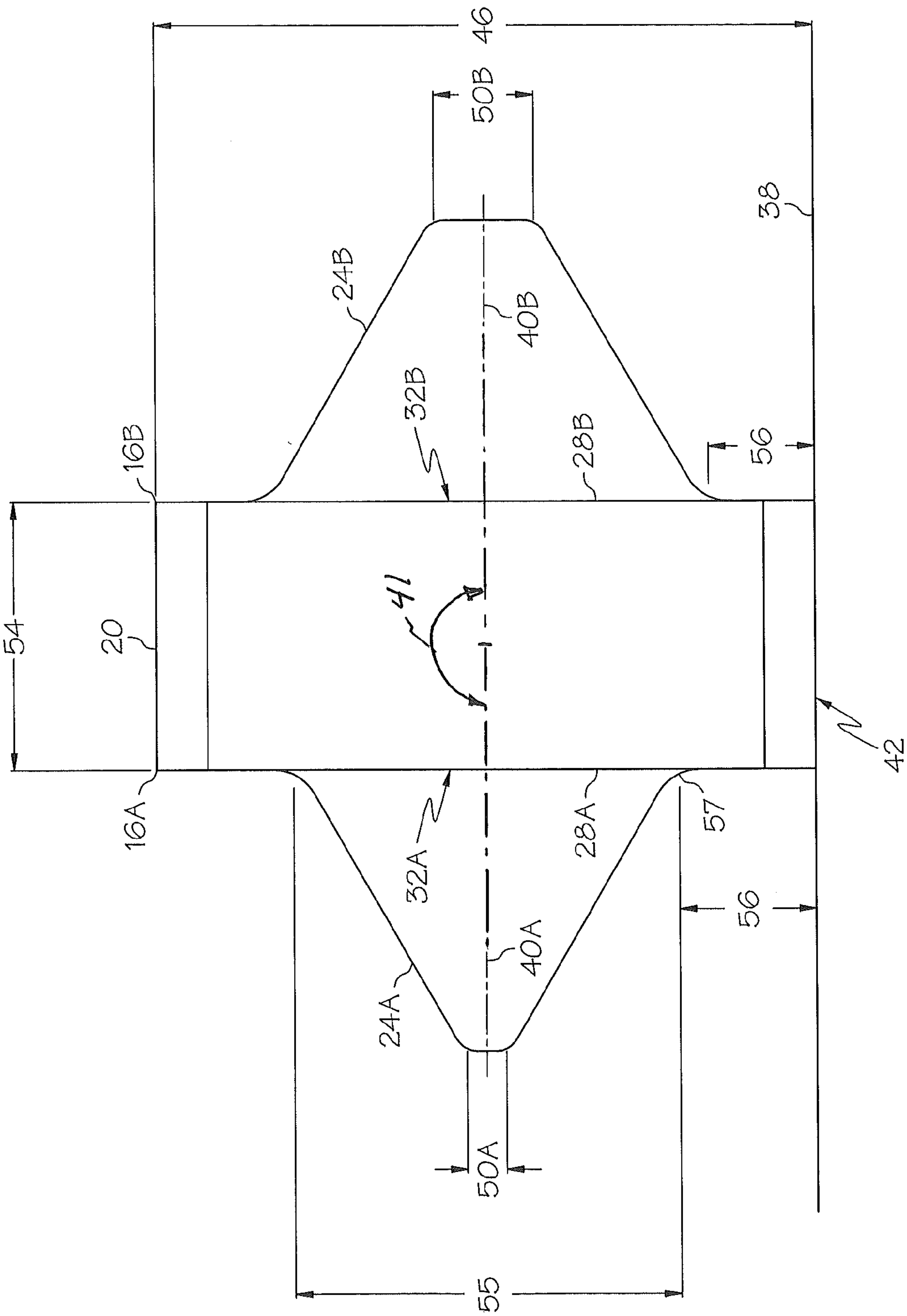
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55

FIG. 1

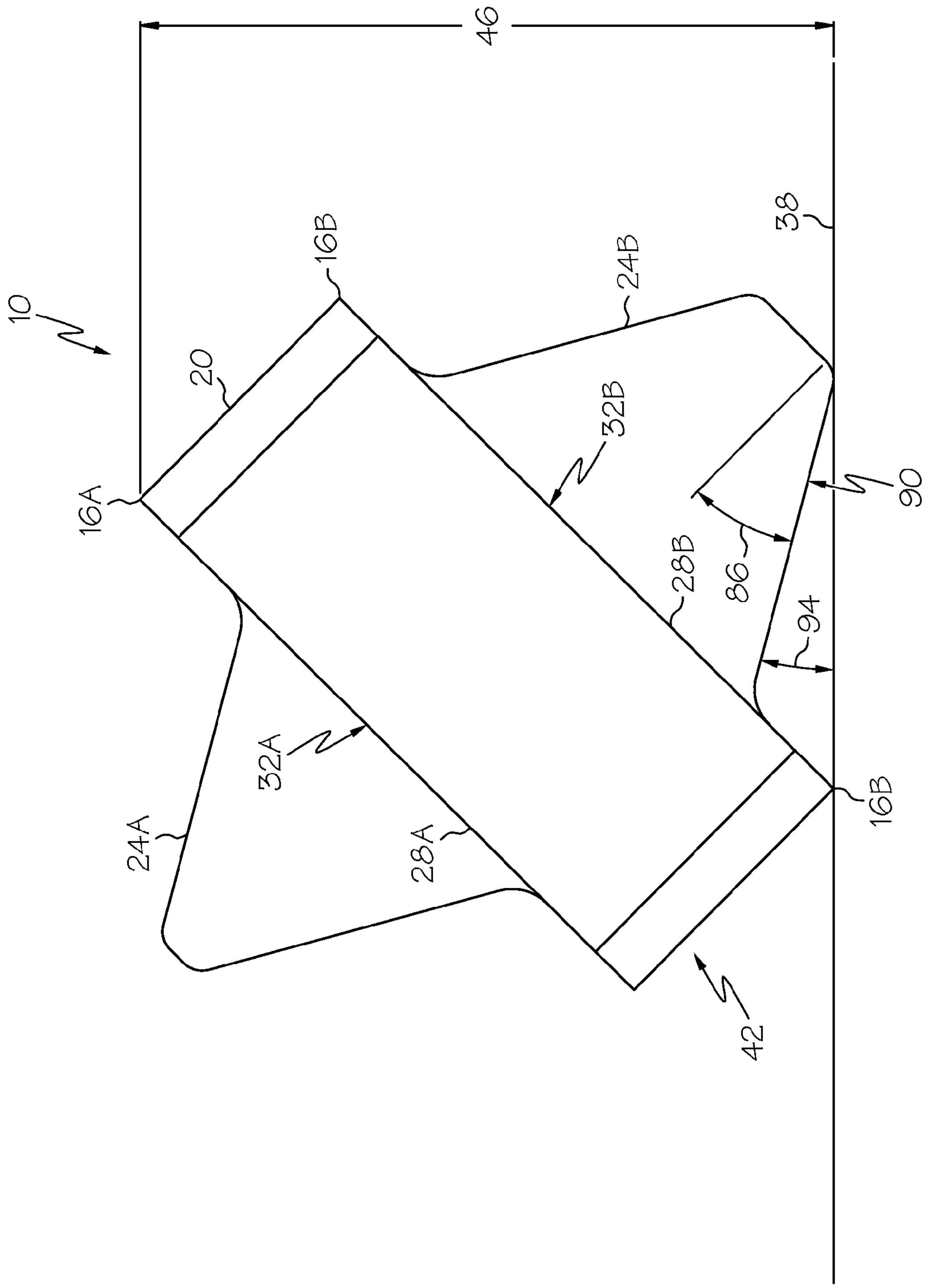

FIG. 2

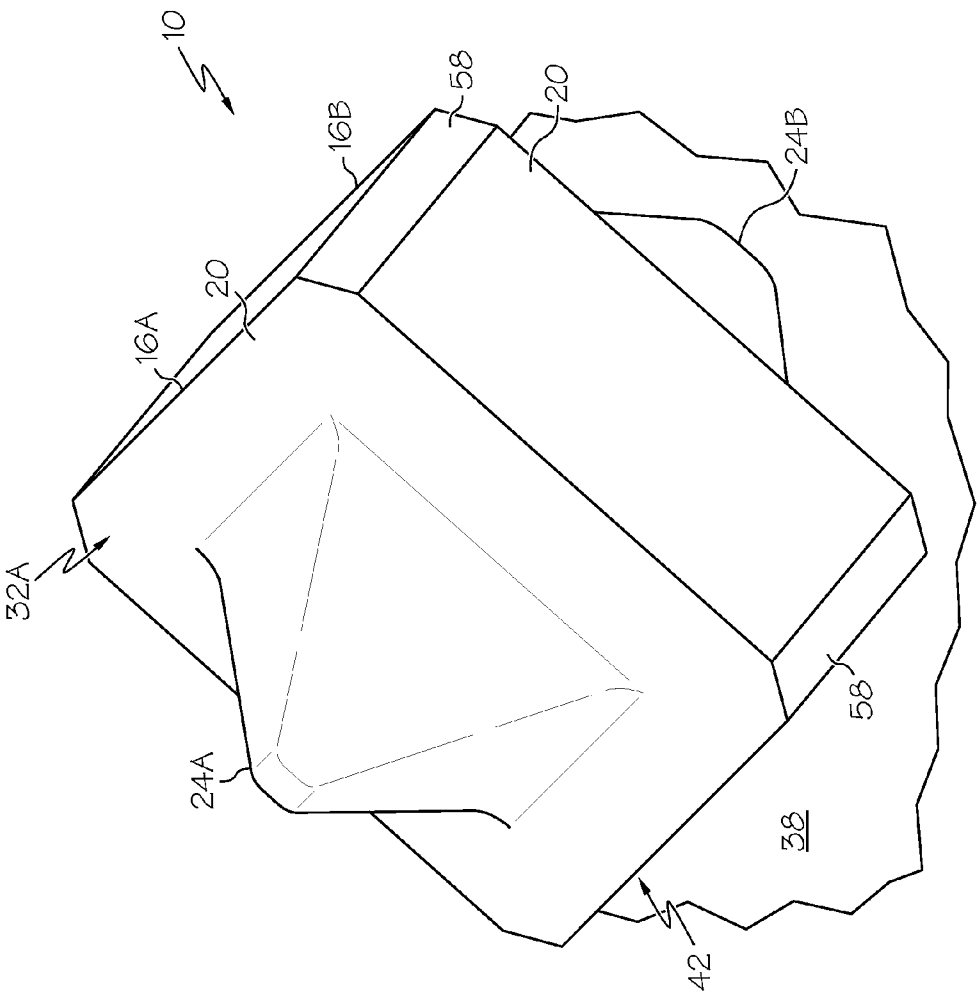

FIG. 3

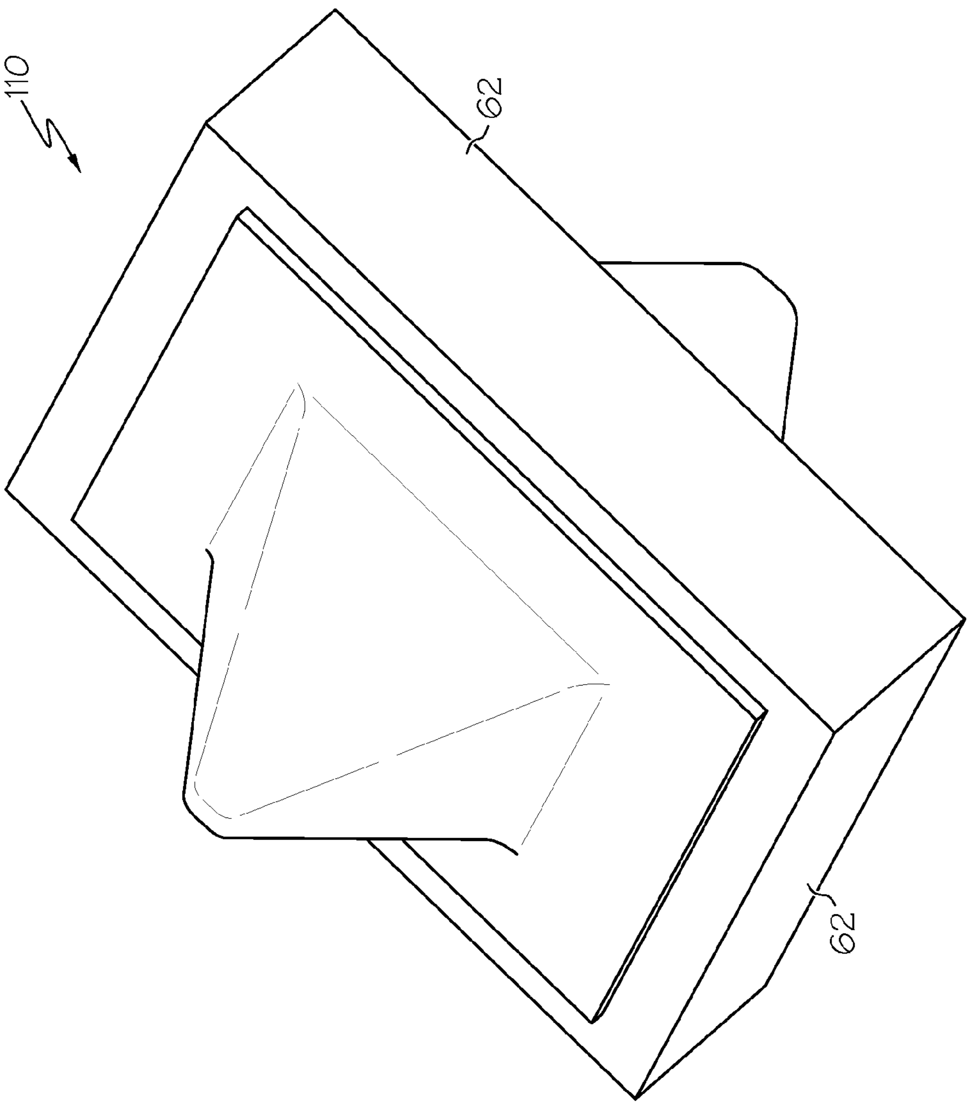

FIG. 4

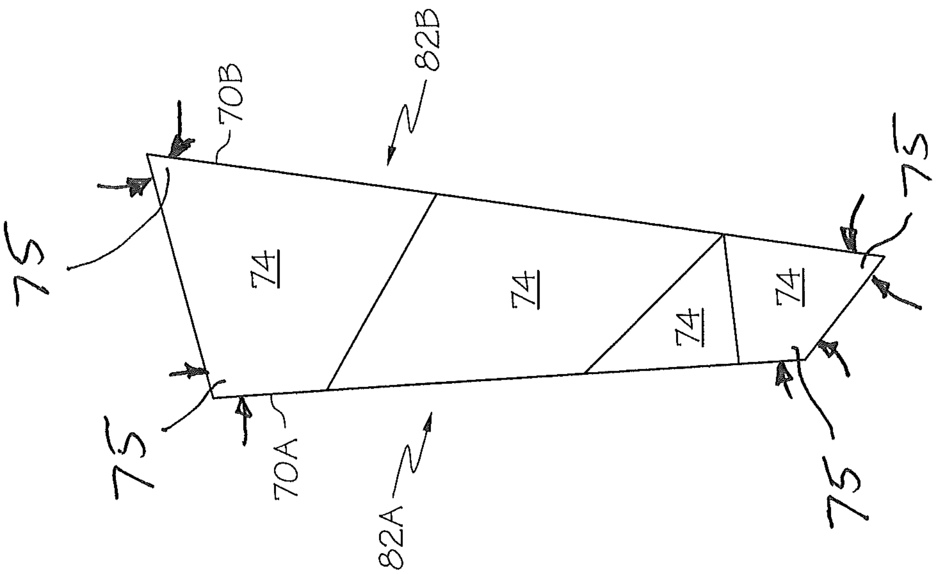
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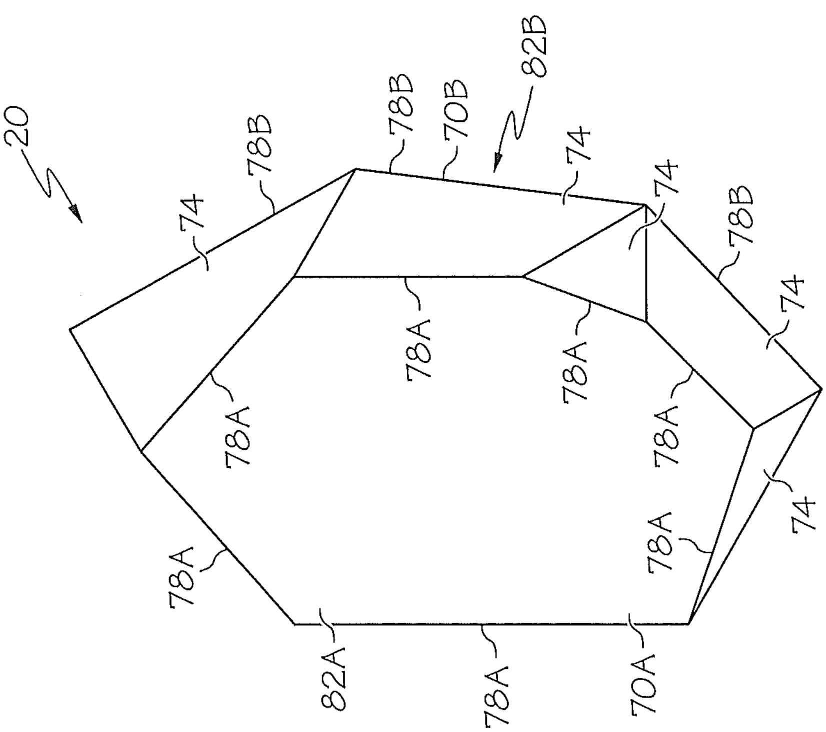
FIG. 6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70A

FIG. 5

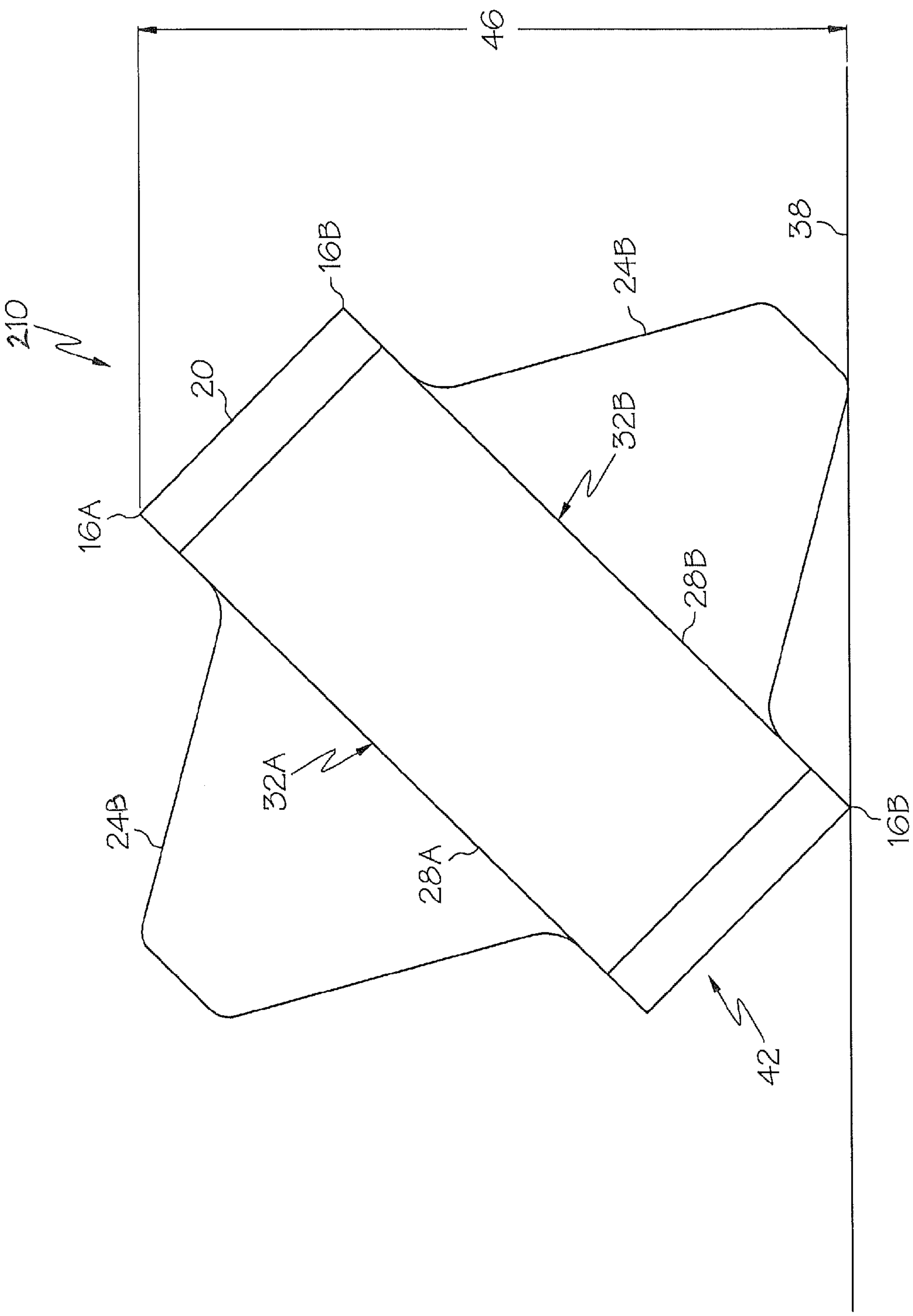

FIG. 7

METHOD OF ORIENTING A CUTTING ELEMENT

CROSS-REFERENCE TO RELATED APPLICATION

This application is a division of U.S. patent application Ser. No. 12/700,845, filed Feb. 5, 2010, the disclosure of which is incorporated by reference herein in its entirety.

BACKGROUND

Cutting tools, such as mills used in downhole applications, for example, can be made with a plurality of cutting elements that are adhered to a surface of a tool. The cutting elements can be randomly shaped particles made by fracturing larger pieces. Alternately, cutting elements can be precisely formed into repeatable shapes using processes such as machining and molding, for example. Regardless of the process employed to make the individual cutting elements the elements are typically adhered to the mill with random orientations. These random orientations create disparities in maximum heights relative to a surface of the mill. Additionally, large disparities may exist between the heights of the portions of the cutting elements that engage the target material during a cutting operation. Furthermore, angles of cutting surfaces relative to the target material are randomized and consequently few are near preferred angles that facilitate efficient cutting. Apparatuses and methods to lessen the foregoing drawbacks would therefore be well received in the industry.

BRIEF DESCRIPTION

Further disclosed herein is a method of orienting a cutting element. The method includes, configuring the cutting element so that gravitational forces acting thereon against a support surface bias the cutting element to an orientation relative to the support surface in which at least one support and at least one side of a polygon of a gilmoid contact the support surface.

BRIEF DESCRIPTION OF THE DRAWINGS

The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

FIG. **1** depicts a side view of a cutting element disclosed herein;

FIG. **2** depicts another side view of the cutting element of FIG. **1**, shown resting at an alternate orientation on a surface;

FIG. **3** depicts a perspective view of the cutting element of FIGS. **1** and **2**, shown resting at the orientation of FIG. **2**;

FIG. **4** depicts a perspective view of an alternate embodiment of a cutting element disclosed herein;

FIG. **5** depicts a perspective view of a central portion of the cutting element; and

FIG. **6** depicts a side view of the central portion of the cutting element of FIG. **5**.

FIG. **7** depicts a side view of an alternate embodiment of a cutting element disclosed herein.

DETAILED DESCRIPTION

A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

Referring to FIG. **1**, an embodiment of a cutting element disclosed herein is illustrated at **10**. The cutting element **10** includes, a central portion **20** disclosed herein as a gilmoid, as will be described in detail below with reference to FIGS. **5** and **6**, defining a plurality of cutting edges **16**A, **16**B, and two supports **24**A and **24**B that extend beyond surfaces **32**A and **32**B that define certain volumetric boundaries of the gilmoid **20**. In this embodiment the supports **24**A and **24**B are not symmetrical to one another to produce a biasing force in response to gravity acting thereon toward a surface **38**, such that one of the supports **24**A, **24**B and one of the cutting edges **16**A, **16**B are in contact with surface **38**. Additionally, the supports **24**A, **24**B in this embodiment have a pyramidal shape.

Referring to FIGS. **2** and **3**, the biasing forces tend to cause the cutting element **10** to reorient from the position illustrated in FIG. **1** to the position illustrated in FIGS. **2** and **3**. The cutting element **10**, as illustrated in FIGS. **2** and **3**, is resting on the surface **38** such that both the support **24**B and one of the cutting edges **16**B is in contact with the surface **38**. The cutting edges **16**A, in this position, are oriented with the surface **32**A at an approximately 45 degree (and preferably between 35 and 55 degrees) angle relative to the surface **38**, and represent a preferred cutting orientation that can cut with greater efficiency than alternate angles. In contrast, the cutting element **10** in FIG. **1** is positioned such that just one face **42**, defined between the two cutting edges **16**A and **16**B, is in contact with the surface **38**. In this position a longitudinal axes of the gilmoid **20** is substantially parallel with the surface **38**. Additionally, although axes **40**A, **40**B of the supports **24**A, **24**B are illustrated herein with an angle **41** of 180 degrees between them, angles of 120 degrees or more are contemplated.

The cutting element **10** is further geometrically configured so that when the cutting element **10** is resting on the surface **38**, regardless of its orientation, a dimension **46** to a point on the cutting element **10** furthest from the surface **38** is substantially constant. This assures a relatively even distribution of cutting forces over a plurality of the cutting elements **10** adhered to the surface **38**.

The foregoing structure allows a plurality of the cutting elements **10** to be preferentially oriented on the surface **38** prior to being fixedly adhered to the surface **38**. While orientations of each of the cutting elements **10** is random in relation to a direction of cutting motion the biasing discussed above orients a majority of the cutting elements **10** as shown in FIGS. **2** and **3** relative to the surface **38**. Having a majority of the cutting elements **10** oriented as shown in FIGS. **2** and **3** improves the cutting characteristics of a cutter employing these cutting elements **10** over cutters employing non-biasing cutting elements.

The supports **24**A and **24**B illustrated herein are geometrically asymmetrical, as is made obvious by the difference in widths **50**A and **50**B of the supports **24**A and **24**B, respectively. This asymmetry creates the asymmetrical bias discussed above in response to gravitational forces acting on the cutting element **10** in a direction parallel to the surfaces **32**A, **32**B. Alternate embodiments are contemplated that have supports that are geometrically symmetrical while providing the asymmetrical bias with gravity. A difference in density between such supports is one way to create such an asymmetrical gravitational bias with geometrically symmetrical supports.

A width **54** of the central portion **20**, defined between the planes **28**A and **28**B, can be set large enough to provide strength sufficient to resist fracture during cutting while being small enough to allow the gravitational asymmetrical bias on the cutting element **10** to readily reorient the cutting element **10** relative to the surface **38** and be effective as a cutting element.

Additionally in this embodiment, by making a base dimension **55**, defined as where the supports **24**A, **24**B intersect with the surfaces **32**A, **32**B, smaller than the dimension **46**, a right angled intersection is defined at the cutting edges **16**A, **16**B. A distance **56** between an intersection **57** of the supports **24**A, **24**B with the surfaces **32**A, **32**B and the faces **42**, **58**, **62** provides a space where the material being cut can flow and can create a barrier to continued propagation of a crack formed in one of the cutting edges **16**A, **16**B beyond the intersections **57**. Preferably, the base dimension **55** is sized to be between 40 and 80 percent of the dimension **46** and more preferably about 60 percent. The 40 to 80 percent requirement combined with the 35 to 55 degree angle limitation discussed above results in flank angle **86** values of between about 15.6 and 29 degrees wherein the flank angle **86** is defined as the angle between a flank face **90** and an axis of the support that is substantially perpendicular to the at least one plan **32**B. Additionally, the flank face **90** forms an angle **94** of between about 19.4 and 26 degrees relative to the surface **38**.

Referring to FIG. **3**, additional faces **58** defined between the cutting edges **16**A and **16**B can be incorporated as well. In fact, any number of faces **42**, **58** can be provided between the cutting edges **16**A and **16**B thereby forming a polygonal prism of the central portion **20**, including just four faces **62** as illustrated in FIG. **4** in an alternate embodiment of a cutting element **110** disclosed herein.

The cutting elements **10**, **110** disclosed herein may be made of hard materials that are well suited to cutting a variety of materials including, for example, those commonly found in a downhole wellbore environment such as stone, earth and metal. These hard materials, among others, include steel, tungsten carbide, tungsten carbide matrix, polycrystalline diamond, ceramics and combinations thereof. However, it should be noted that since polycrystalline diamond is not a required material some embodiments of the cutting elements **10**, **110** disclosed may be made of hard materials while excluding polycrystalline diamond therefrom.

Although the embodiments discussed above are directed to a central portion **20** that is a polygonal prism, alternate embodiments can incorporate a central portion **20** that has fewer constraints than is required of a polygonal prism. As such, the term gilmoid has been introduced to define the requirements of the central portion **20**. Referring to FIGS. **5** and **6**, the gilmoid **20** is illustrated without supports **24**A, **24**B shown. The gilmoid **20** is defined by two polygons **70**A, **70**B with surfaces **74** that connect sides **78**A of the polygon **70**A to sides **78**B of the other polygon **70**B. The two polygons **70**A, **70**B can have a different number of sides **78**A, **78**B from one another, and can have a different area from one another. Additionally, planes **82**A, **82**B, in which the two polygons **70**A, **70**B exist, can be parallel to one another or can be nonparallel to one another, as illustrated. In embodiments wherein the planes **70**A and **70**B are not parallel to one another such is shown in FIG. **6**, included angles **75** between the surfaces **74** and the planes **70**A and **70**B can be in a range of about 80 to 100 degrees.

Referring to FIG. **7**, an alternative embodiment of a cutting element disclosed herein is illustrated at **210**. Many of the characteristics of the element **210** are similar to the element **10** and as such like features are numbered alike and are not described again herein. Unlike the element **10**, however, the element **210** includes two supports **24**B that extend from opposing surfaces **32**A and **32**B of the gilmoid **20**. The two supports **24**B are dimensioned the same as one another thereby making the cutting element **210** symmetrical. An embodiment wherein the supports **24**A and **24**B (shown in FIG. **2**) may be geometrically symmetrical is also described above with reference to FIG. **2**.

While the invention has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

What is claimed is:

1. A method of orienting a cutting element, comprising configuring the cutting element having a gilmoid having a plurality of edges formed by intersections of surfaces, and at least one support extending directly from at least one of the surfaces so that gravitational forces acting thereon against a planar support surface preferentially bias the cutting element toward an orientation relative to the planar support surface in which the at least one support and at least one of the plurality of edges contact the planar support surface with the at least one of the surfaces extending at an acute angle relative to the planar support surface in preparation for being fixedly adhered to the planar support surface.

2. The method of orienting a cutting element of claim **1**, wherein the configuring the cutting element includes distributing weight of the cutting element.

3. The method of orienting a cutting element of claim **1**, further comprising distributing weight of the cutting element asymmetrically.

4. The method of orienting a cutting element of claim **3**, further comprising distributing weight of the cutting element asymmetrically beyond a volume of the gilmoid.

5. The method of orienting a cutting element of claim **3**, further comprising distributing weight asymmetrically by altering density of different portions of the cutting element.

6. The method of orienting a cutting element of claim **3**, further comprising distributing weight asymmetrically by selecting different densities for the at least one support and another of the at least one support.

7. The method of orienting a cutting element of claim **1**, wherein the configuring the cutting element includes geometrically shaping the cutting element.

8. The method of orienting a cutting element of claim **1**, further comprising geometrically shaping the cutting element asymmetrically.

9. The method of orienting a cutting element of claim **1**, further comprising geometrically shaping the cutting element such that a shape of one of the at least one supports is different than a shape of another of the at least one supports.

10. The method of orienting a cutting element of claim **9**, wherein the difference in shape of the one of the at least one supports includes a difference in size of a base of another of the at least one supports.

11. The method of orienting a cutting element of claim **1**, wherein the acute angle defines an angle of between about 35 degrees and about 55 degrees relative to the planar support surface.

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